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(54) **METHOD OF FORMING FIN-SHAPED STRUCTURE**

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CPC combination set(s) only.
See application file for complete search history.

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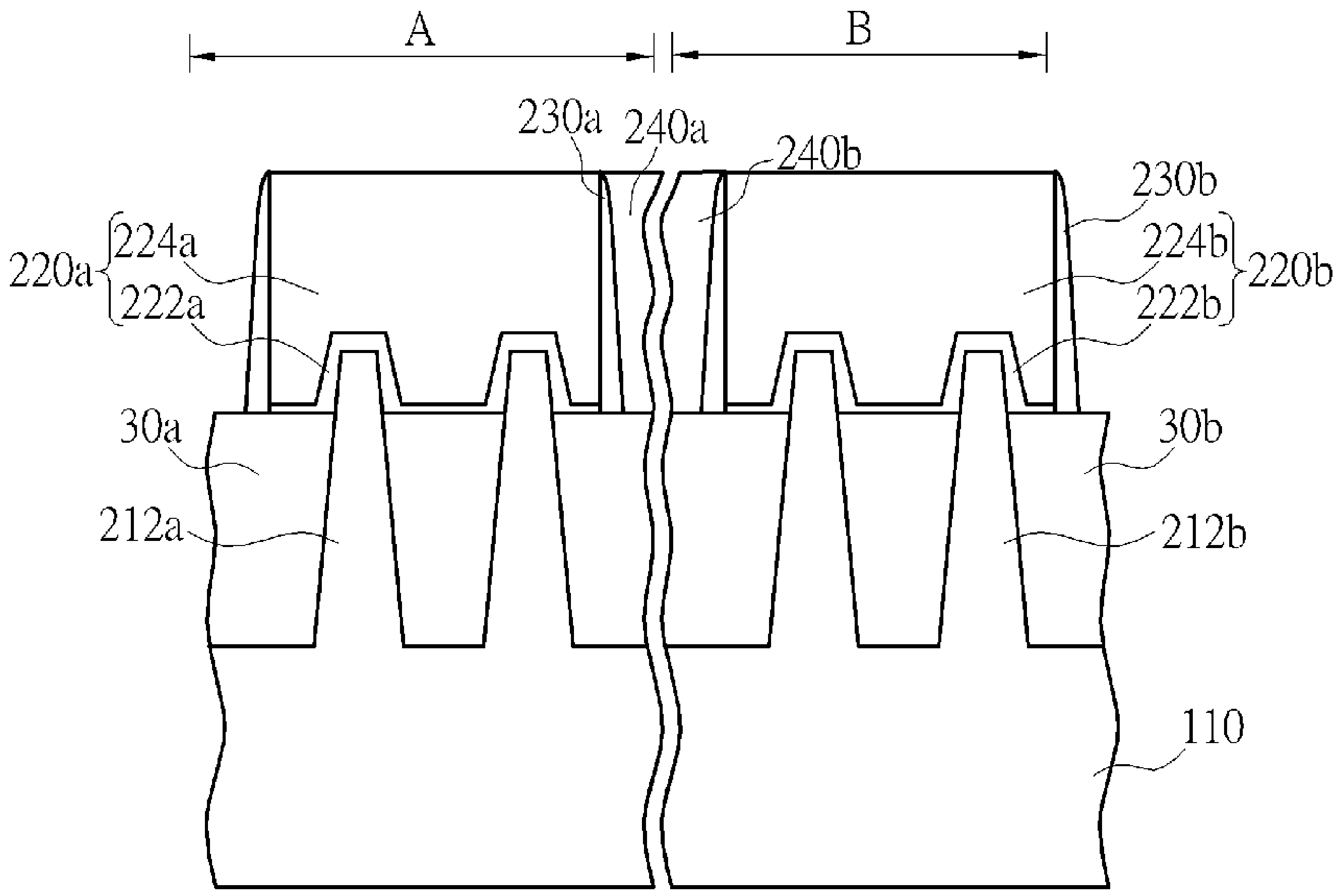
(74) *Attorney, Agent, or Firm* — Winston Hsu

(57) **ABSTRACT**

A fin-shaped structure includes a substrate having a first fin-shaped structure located in a first area and a second fin-shaped structure located in a second area, wherein the second fin-shaped structure includes a ladder-shaped cross-sectional profile part. The present invention also provides two methods of forming this fin-shaped structure. In one case, a substrate having a first fin-shaped structure and a second fin-shaped structure is provided. A treatment process is performed to modify an external surface of the top of the second fin-shaped structure, thereby forming a modified part. A removing process is performed to remove the modified part through a high removing selectivity to the first fin-shaped structure and the second fin-shaped structure, and the modified part, thereby the second fin-shaped structure having a ladder-shaped cross-sectional profile part is formed.

7 Claims, 5 Drawing Sheets



Related U.S. Application Data

division of application No. 14/512,475, filed on Oct. 13, 2014, now Pat. No. 9,786,510.

(51) **Int. Cl.**

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H01L 21/306	(2006.01)
H01L 29/66	(2006.01)
H01L 21/02	(2006.01)

(52) **U.S. Cl.**

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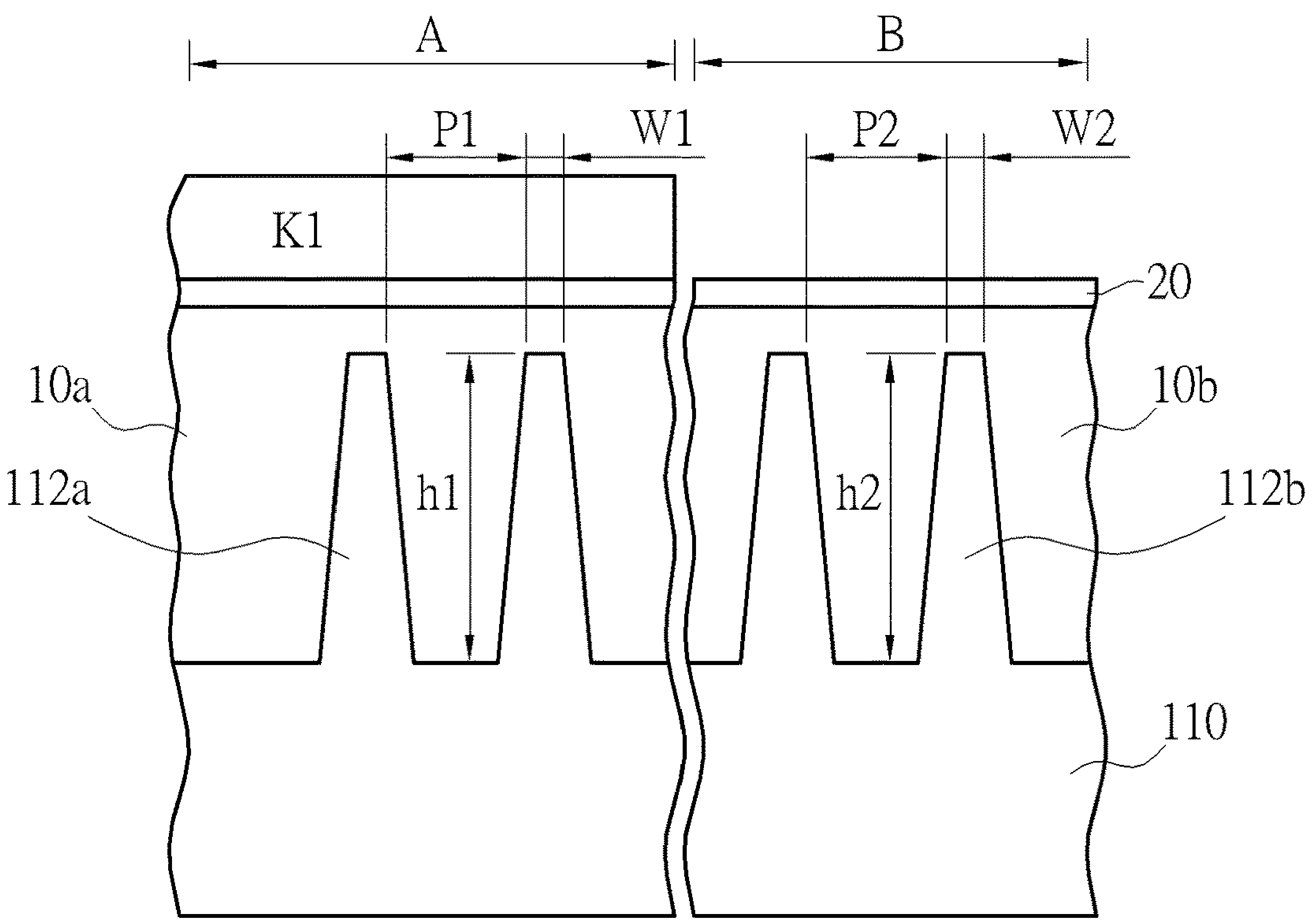
A
B
P1
W1
P2
W2
K1
20
10a
10b
112a
h1
h2
112b
110

FIG. 1

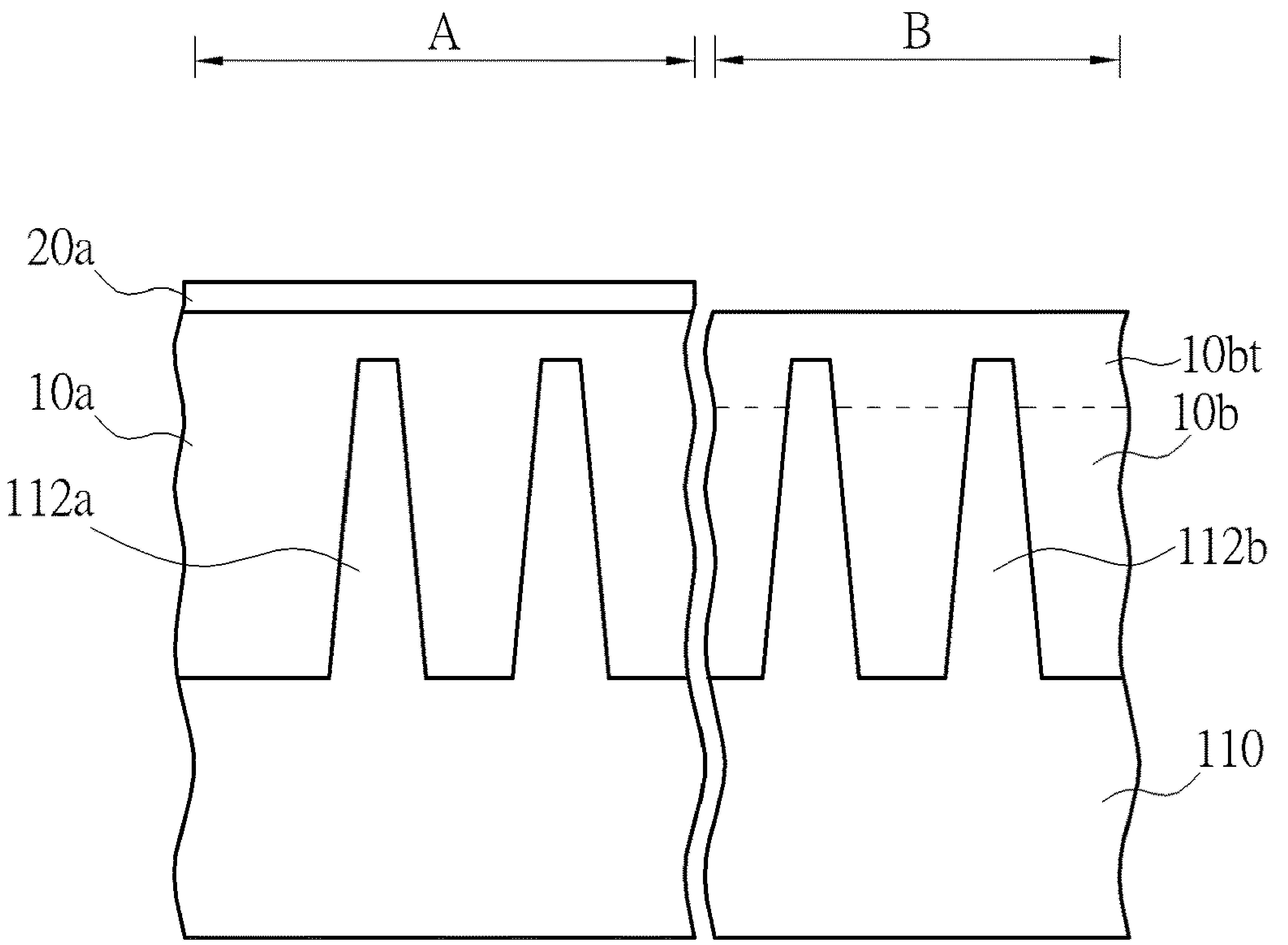
A
B
20a
10bt
10a
10b
112a
112b
110

FIG. 2

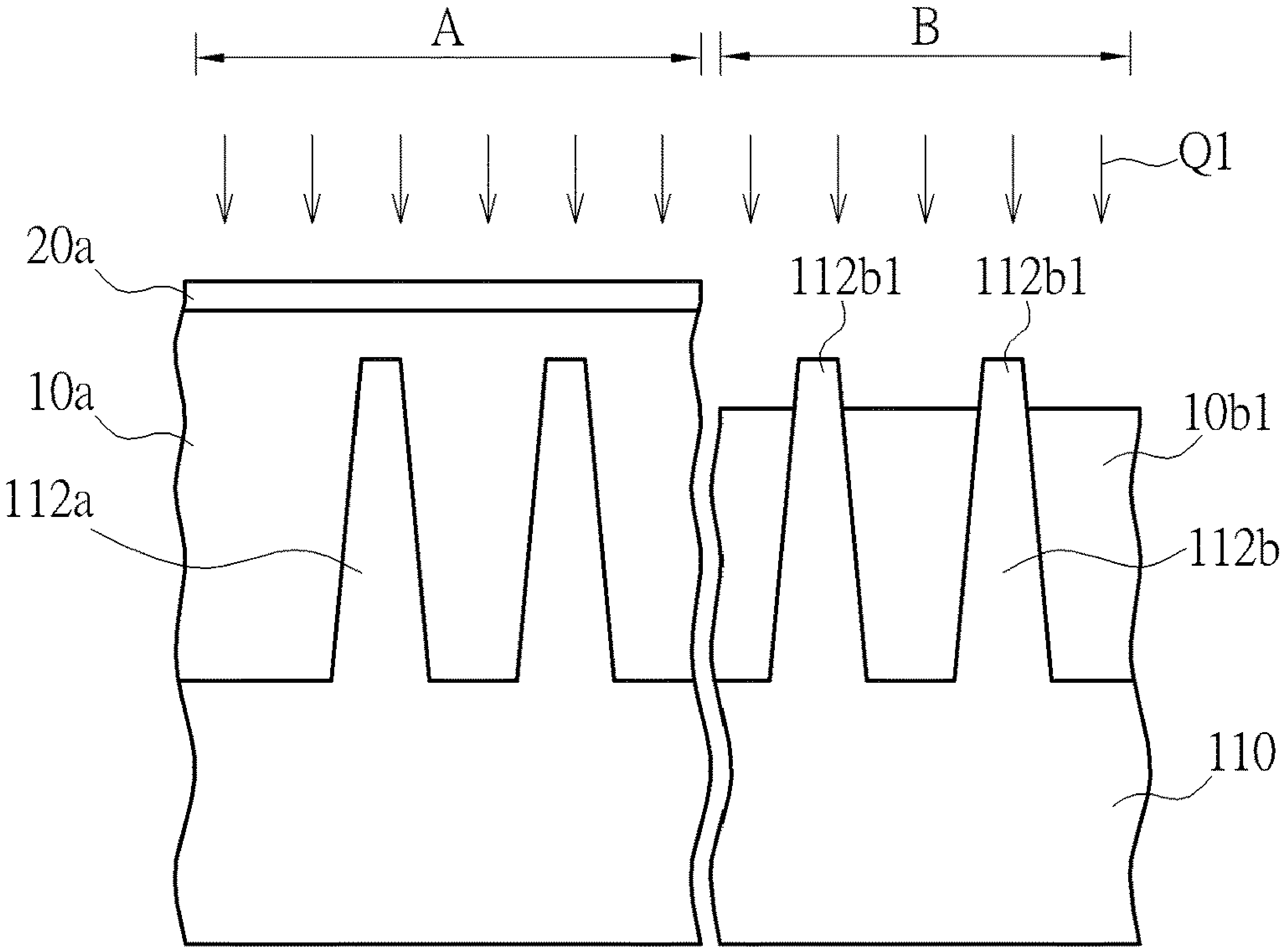
A
B
Q1
20a
112b1
112b1
10a
10b1
112a
112b
110

FIG. 3

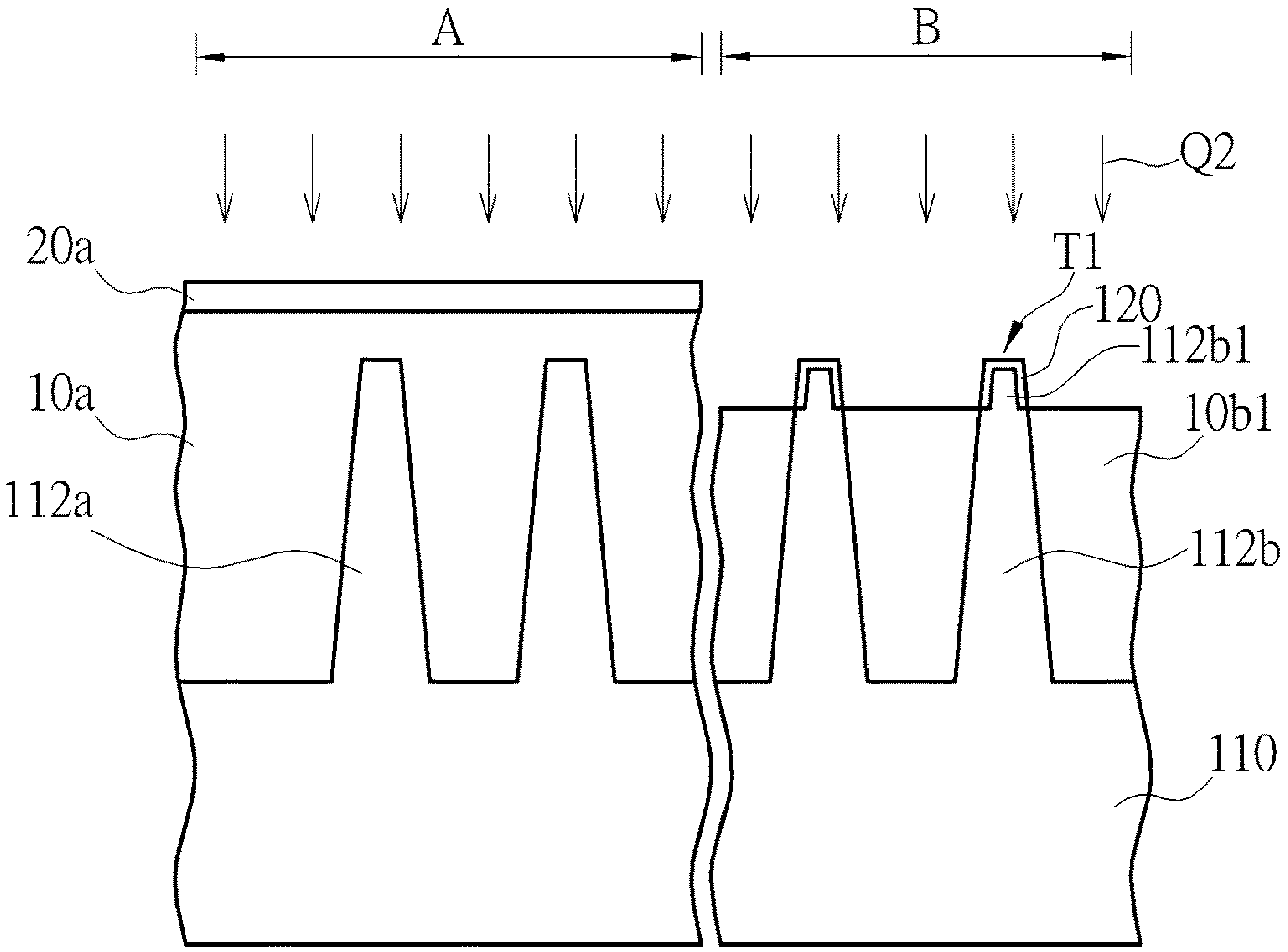
A
B
Q2
20a
T1
120
112b1
10a
10b1
112a
112b
110

FIG. 4

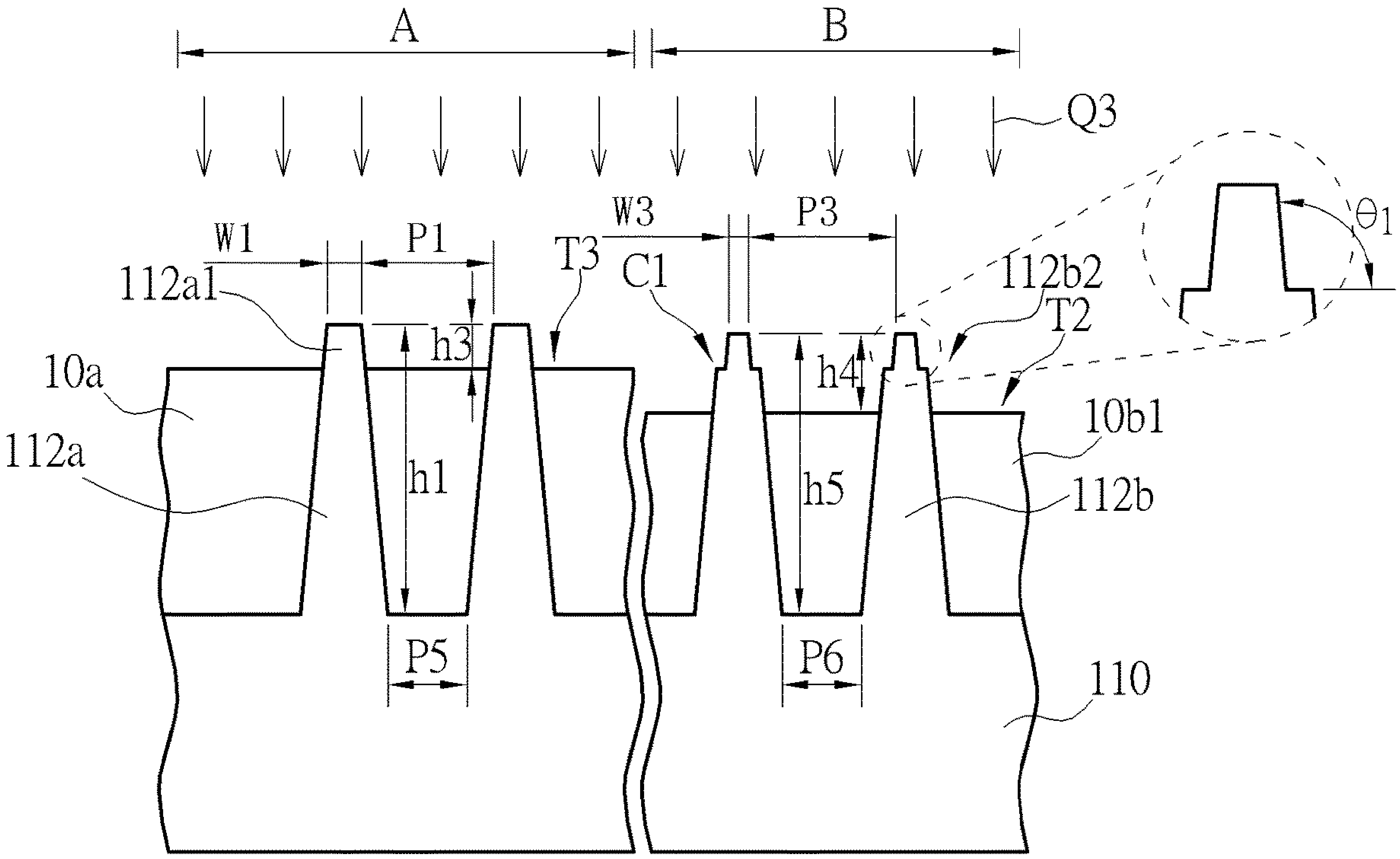
A
B
Q3
W1
P1
W3
P3
θ1
112a1
T3
C1
112b2
h3
T2
h4
10a
10b1
112a
h1
h5
112b
P5
P6
110

FIG. 5

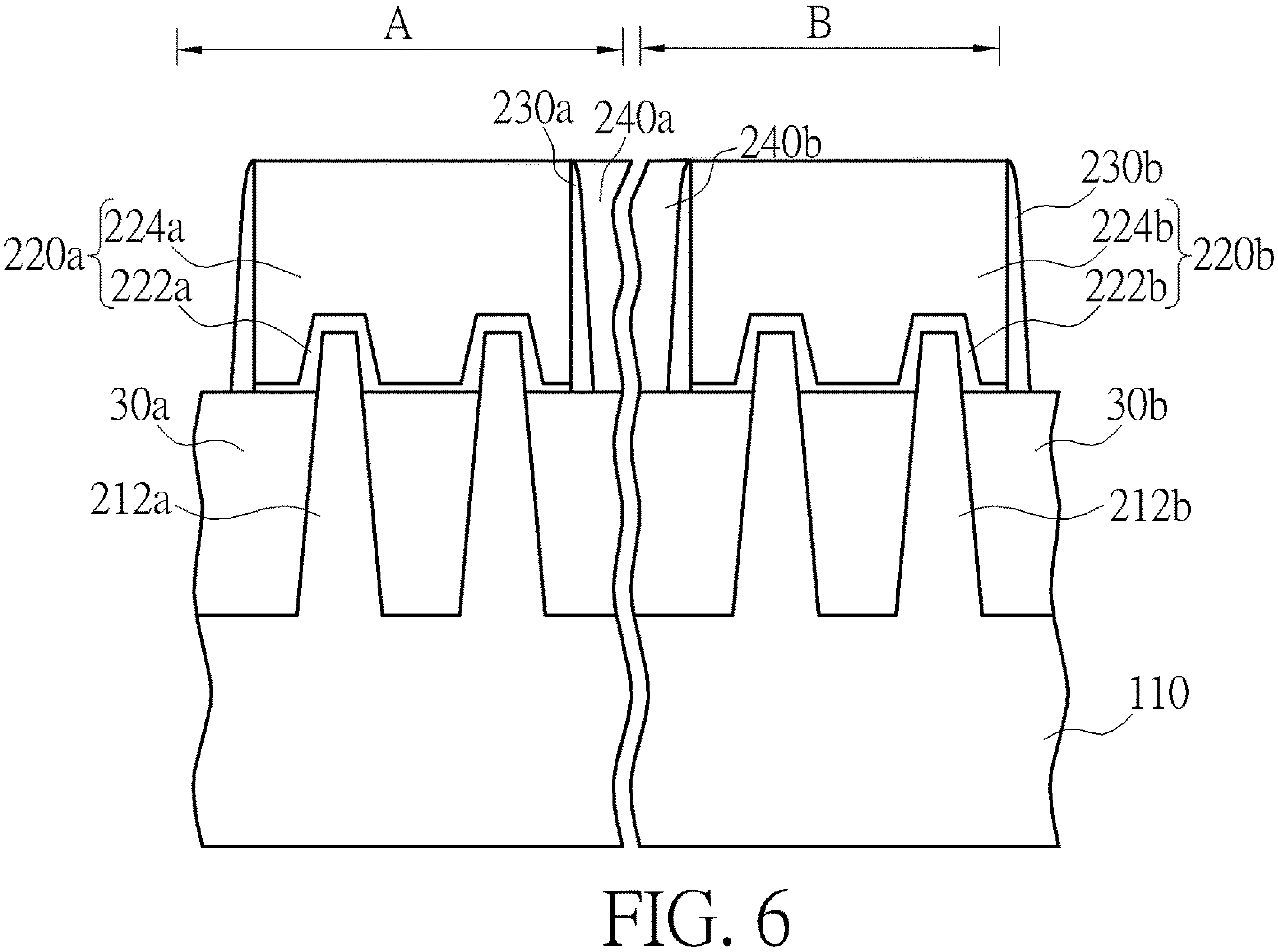
A
B
230a
240a
240b
230b
220a
224a
222a
224b
222b
220b
30a
30b
212a
212b
110

FIG. 6

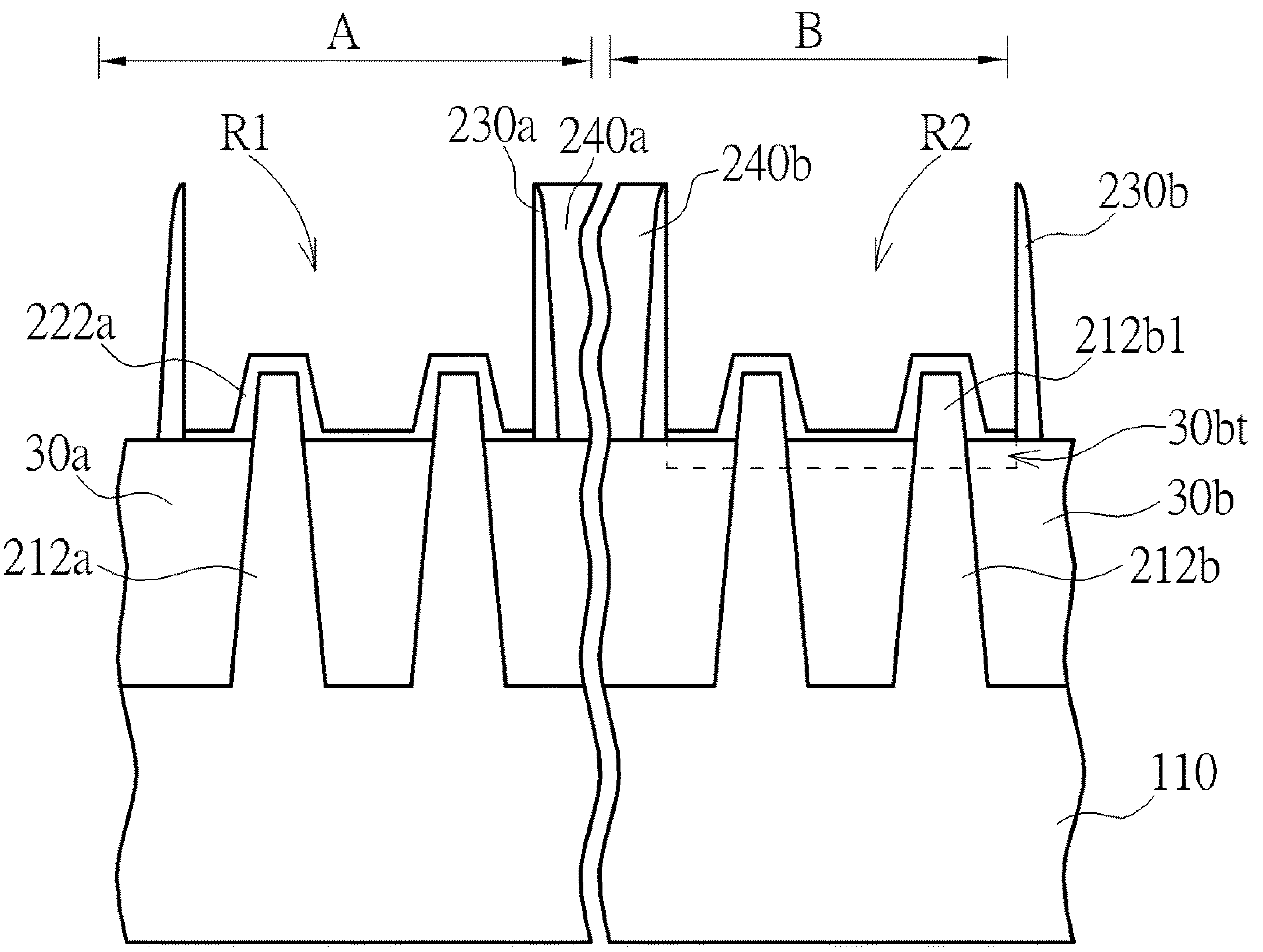
A
B
R1
230a
240a
240b
R2
230b
222a
212b1
30bt
30a
30b
212a
212b
110

FIG. 7

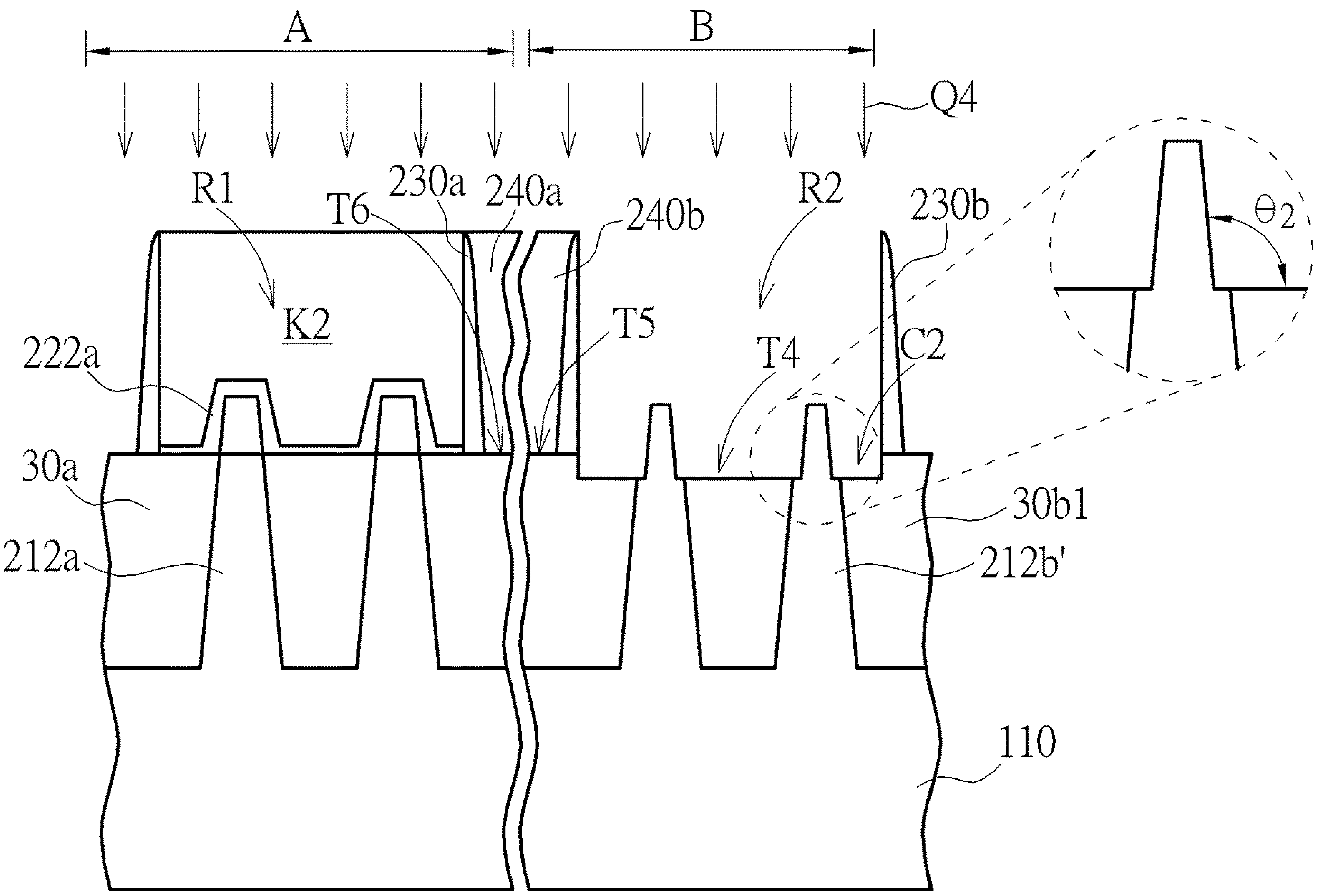
A
B
Q4
R1
T6
230a
240a
240b
R2
230b
θ_2
K2
T5
T4
C2
222a
30a
30b1
212a
212b'
110

FIG. 8

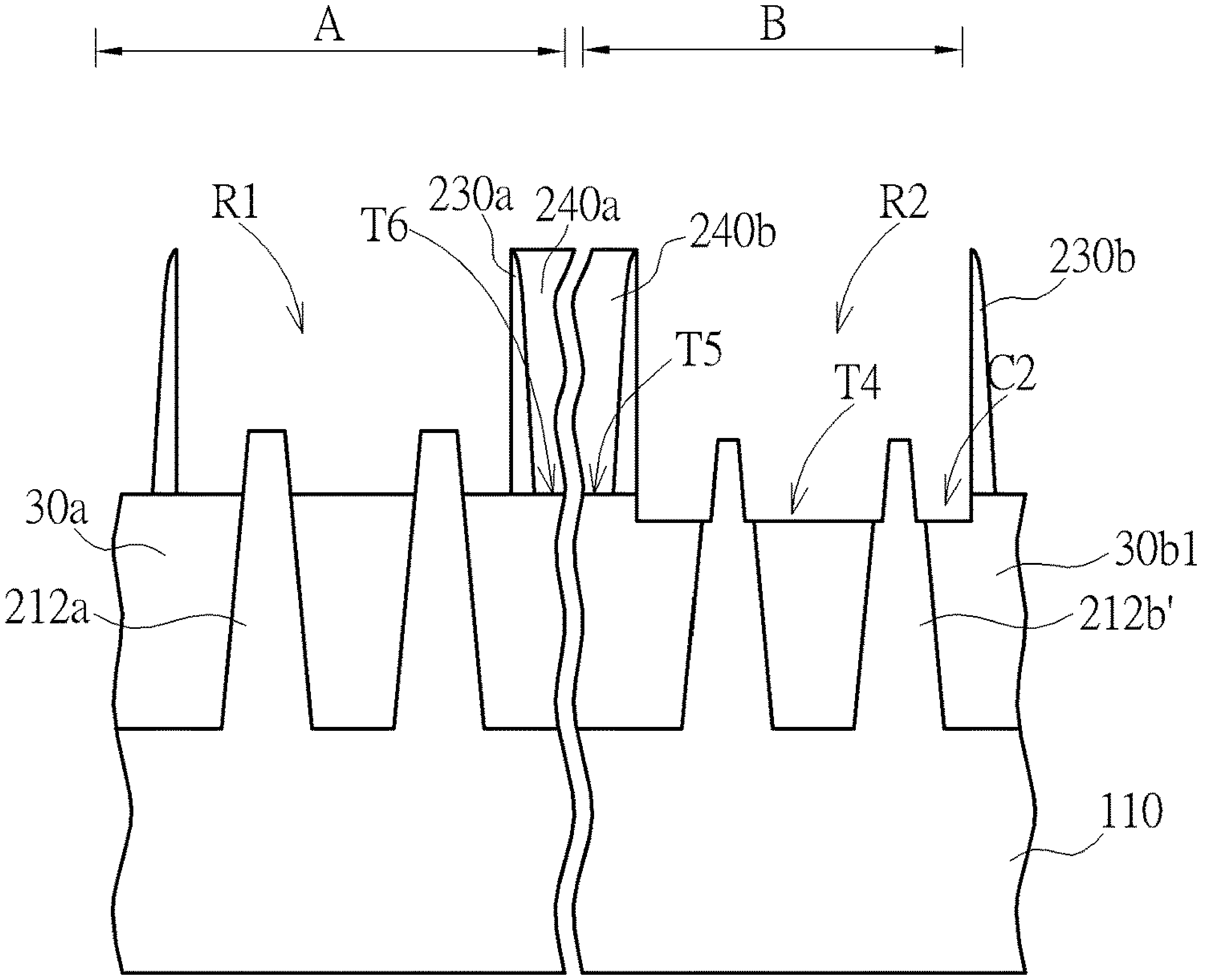
A
B
R1
T6
230a
240a
240b
R2
230b
T5
T4
C2
30a
212a
30b1
212b'
110

FIG. 9

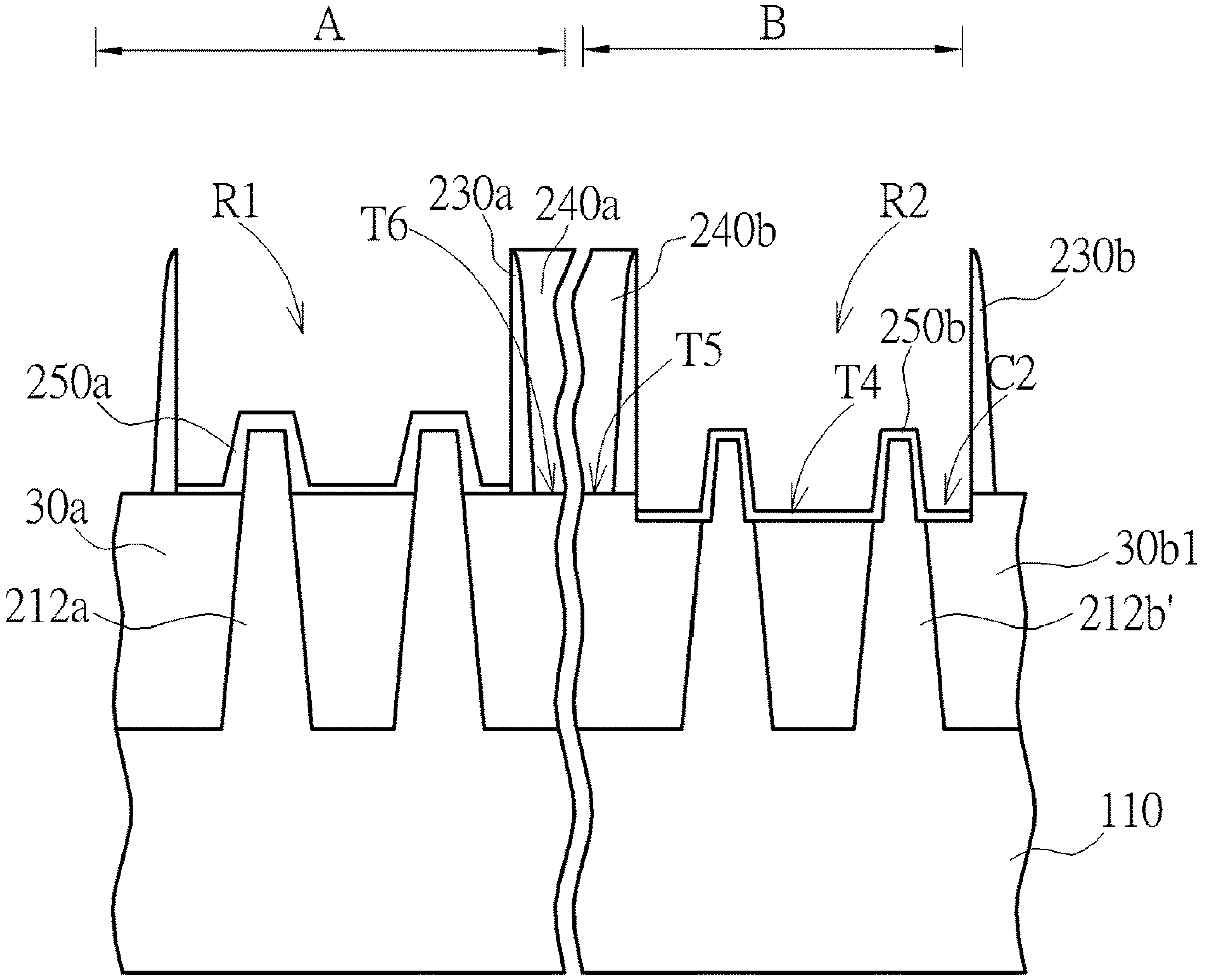
A
B
R1
T6
230a
240a
240b
R2
230b
250b
T5
T4
C2
250a
30a
212a
30b1
212b'
110

FIG. 10

METHOD OF FORMING FIN-SHAPED STRUCTURE

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a divisional application of and claims the benefit of U.S. patent application Ser. No. 15/688,885, which is a divisional application of and claims the benefit of U.S. patent application Ser. No. 14/512,475, filed Oct. 13, 2014.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to a fin-shaped structure and method thereof, and more specifically to a fin-shaped structure which has a ladder-shaped cross-sectional profile, and a method thereof.

2. Description of the Prior Art

With increasing miniaturization of semiconductor devices, various multi-gate MOSFET devices have been developed. The multi-gate MOSFET is advantageous for the following reasons. Manufacturing processes of multi-gate MOSFET devices can be integrated into traditional logic device processes, and thus are more compatible. In addition, since the three-dimensional structure of the multi-gate MOSFET increases the overlapping area between the gate and the substrate, the channel region is controlled more effectively, which reduces drain-induced barrier lowering (DIBL) effect and short channel effect. Moreover, the channel region is longer for the same gate length, so the current between the source and the drain is increased.

Since transistors in different areas such as logic areas and input/output areas have different purposes, structures of these transistors should be tailored to suit their particular purposes. When forming the structures, electrical demands in each area should be considered.

SUMMARY OF THE INVENTION

The present invention provides a fin-shaped structure and method thereof, which selectively forms fin-shaped structures having ladder-shaped cross-sectional profile parts in some areas, so that fin-shaped structures of different heights and critical dimensions (CD) can be formed, in order to form transistors for each area that meet each area's specific electrical demands.

The present invention provides a fin-shaped structure including a substrate having a first fin-shaped structure located in a first area and a second fin-shaped structure located in a second area, wherein the second fin-shaped structure includes a ladder-shaped cross-sectional profile part.

The present invention provides a method of forming a fin-shaped structure including the following steps. A substrate having a first fin-shaped structure located in a first area and a second fin-shaped structure located in a second area is provided. An isolation structure is filled beside the first fin-shaped structure of the first area and beside the second fin-shaped structure of the second area. A patterned mask is formed to cover the first area and expose the second area. A top part of the isolation structure of the second area is removed, to expose a first top part of the second fin-shaped structure. A treatment process is performed to modify an external surface of the first top part of the second fin-shaped structure, to form a modified part covering the first top part of the second fin-shaped structure. The patterned mask is removed. A removing process is performed to remove a part of the isolation structure and the modified part by the high removing selectivity to the first fin-shaped structure and the second fin-shaped structure, and the modified part and the isolation structure, to expose a top part of the first fin-shaped structure and a second top part of the second fin-shaped structure.

The present invention provides a method of forming a fin-shaped structure including the following steps. A substrate having a first fin-shaped structure located in a first area and a second fin-shaped structure located in a second area is provided. A first gate across the first fin-shaped structure and a second gate across the second fin-shaped structure are formed, wherein the first gate sequentially includes a first dielectric layer and a first sacrificial gate covering the first fin-shaped structure, and the second gate sequentially includes a second dielectric layer and a second sacrificial gate covering the second fin-shaped structure. The first sacrificial gate and the second sacrificial gate are removed, thereby exposing the first dielectric layer and the second dielectric layer. A mask covers the first area and exposes the second area. A removing process is performed to remove an external surface of a top part of the second fin-shaped structure. The mask is then removed.

According to the above, the present invention provides a fin-shaped structure and method thereof, which covers a mask in a first area, and then removes an external surface of a top part of a second fin-shaped structure of a second area, so that the second fin-shaped structure having a ladder-shaped cross-sectional profile in the second area is formed. Hence, fin-shaped structures of different heights and critical dimensions can be formed, and thus transistors for each area can achieve required electrical requirements. The methods of removing the external surface of the top part of the second fin-shaped structure in the second area may include: a removing process is performed to directly remove the external surface of the top part of the second fin-shaped structure; or, a treatment process may be performed to modify the external surface of the top part of the second fin-shaped structure, and a removing process may be performed to remove the modified part.

These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1-5** schematically depict a cross-sectional view of a method of forming a fin-shaped structure according to a first embodiment of the present invention.

FIGS. **6-10** schematically depict a cross-sectional view of a method of forming a fin-shaped structure according to a second embodiment of the present invention.

DETAILED DESCRIPTION

FIGS. **1-5** schematically depict a cross-sectional view of a method of forming a fin-shaped structure according to a first embodiment of the present invention. As shown in FIG. **1**, a substrate **110** is provided. The substrate **110** can be divided into a first area A and a second area B. In this embodiment, the first area A is a high voltage threshold (HVT) area while the second area B is a low voltage threshold (LVT) area, but this is not limited thereto. The first area A may be an input/output high voltage area while the second area B may be a logic area. For illustrating the present invention clearly, there are only two areas depicted in this embodiment, but the present invention can also be applied to three or more areas at the same time, depending upon practical requirements.

The substrate **110** has two first fin-shaped structures **112***a* in the first area A and two second fin-shaped structures **112***b* in the second area B. In this embodiment, two first fin-shaped structures **112***a* are formed in the first area A and two second fin-shaped structures **112***b* are formed in the second area B, but the number of the first fin-shaped structures **112***a* or the second fin-shaped structures **112***b* is not restricted thereto. In this embodiment, the first fin-shaped structures **112***a* and the second fin-shaped structures **112***b* have the same structure. A height h**1** of each of the first fin-shaped structures **112***a* is common to a height h**2** of each of the second fin-shaped structures **112***b;* a width w**1** of a top part of each of the first fin-shaped structures **112***a* is the same as a width w**2** of a top part of each of second fin-shaped structures **112***b;* and a first distance p**1** between a top part of each of the first fin-shaped structures **112***a* is the same as a distance p**2** between a top part of each of the second fin-shaped structures **112***b*. Therefore, when a selective treatment process is performed on one single area or on a plurality of areas, symmetric structures in these areas will receive the same influence and uniform structures can be formed. The first distance p**1** between a top part of each of the first fin-shaped structures **112***a* may also be different from the distance p**2** between a top part of each of the second fin-shaped structures **112***b*.

More precisely, the method of forming the first fin-shaped structures **112***a* in the first area A and forming the second fin-shaped structures **112***b* in the second area B may include, but is not limited to, the following steps. A bulk bottom substrate (not shown) is provided. A hard mask layer (not shown) may be formed on the bulk bottom substrate (not shown) and is patterned to define the location of the first fin-shaped structures **112***a* and the second fin-shaped structures **112***b* in the bulk bottom substrate (not shown) by a sidewall image transfer process. An etching process is performed to form the first fin-shaped structures **112***a* and the second fin-shaped structures **112***b*. The first fin-shaped structures **112***a* and the second fin-shaped structures **112***b* located in the substrate **110** are then formed completely. In one embodiment, the hard mask layer (not shown) is removed after the first fin-shaped structures **112***a* and the second fin-shaped structures **112***b* are formed, and a tri-gate MOSFET can be formed in the following processes. There are three contact faces between the first fin-shaped structures **112***a* and the second fin-shaped structures **112***b* and the following formed dielectric layer functions as a carrier channel whose width is wider than a channel width in a conventional planar MOSFET. When a driving voltage is applied, the tri-gate MOSFET produces a double on-current compared to the conventional planar MOSFET. In another embodiment, the hard mask layer (not shown) is reserved to form a fin field effect transistor (Fin FET), which is another kind of multi-gate MOSFET. Due to the hard mask layer (not shown) being reserved in the fin field effect transistor, there are only two contact faces between the first fin-shaped structures **112***a* and the second fin-shaped structures **112***b* and the following formed dielectric layer.

The present invention can also be applied to other semiconductor substrates. For example, a silicon-on-insulator substrate (not shown) is provided, and then a single crystalline silicon layer being a top part of the silicon-on-insulator substrate (not shown) is etched till an oxide layer being a middle part of the silicon-on-insulator substrate (not shown) is exposed.

Isolation structures **10***a* and **10***b* are filled beside the first fin-shaped structures **112***a* in the first area A and beside the second fin-shaped structures **112***b* in the second area B. The isolation structures **10***a* and **10***b* may be shallow trench isolation (STI) structures, and may include oxide, but are not limited thereto. In this embodiment, the isolation structures **10***a* and **10***b* are filled beside the first fin-shaped structures **112***a* in the first area A and beside the second fin-shaped structures **112***b* in the second area B simultaneously, and the isolation structures **10***a* and **10***b* have the same height. Therefore, symmetric structures are formed in the first area A and the second area B. As a selective treatment process is performed on one single area or on a plurality of areas, symmetric structures in these areas can receive the same influence and thus uniform structures can be formed. In another embodiment, the isolation structures **10***a* and **10***b* may have different heights and may be formed by different processes, depending upon practical requirements.

After the first fin-shaped structures **112***a* and the second fin-shaped structures **112***b* are formed, a doping process may be selectively performed to form wells in the first area A and the second area B or to change threshold voltages in the two areas.

A patterned mask **20***a* is then formed to cover the first area A but expose the second area B. As shown in FIG. **1**, a mask **20** blanket-covers the first area A and the second area B. A photoresist (not shown) is deposited and patterned to form a patterned photoresist K**1** on the mask **20**, wherein the patterned photoresist K**1** covers the first area A but exposes the second area B. Thereafter, an etching process is performed to remove the exposed mask **20** in the second area B, so a patterned mask **20***a* is formed only in the first area A. Then, the patterned photoresist K**1** is removed, as shown in FIG. **2**. In this embodiment, the patterned mask **20***a* is a silicon nitride layer, but it is not limited thereto.

A removing process Q**1** may be performed to remove a top part **10***bt* of the isolation structure **10***b* in the second area B, to form an isolation structure **10***b***1** and expose first top parts **112***b***1** of the second fin-shaped structures **112***b,* as shown in FIG. **3**. It is emphasized that, due to the patterned mask **20***a* blanket-covering the first area A, the isolation structure **10***a* and the first fin-shaped structures **112***a* are reserved completely without being removed. In this embodiment, the removing process Q**1** may be an ammonia and nitrogen trifluoride containing etching process, which has a high etching selectivity to the isolation structure **10***b* and the second fin-shaped structures **112***b*; that is, the etching rate of the removing process Q**1** to the isolation structure **10***b* is much larger than to the second fin-shaped structures **112***b,* so only the isolation structure **10***b* is removed without removing the second fin-shaped structures **112***b*. In another embodiment, the removing process Q**1** may be other processes, but these processes must have high removing selectivity to the isolation structure **10***b* and the second fin-shaped structures **112***b* in order to remove a part of the isolation structure **10***b* and expose a part of the second fin-shaped structures **112***b*.

As shown in FIG. **4**, a treatment process Q**2** is performed to modify an external surface T**1** of a first top part **112***b***1** of each of the second fin-shaped structures **112***b,* thereby a modified part **120** covering the first top part **112*b*1** of each of the second fin-shaped structures **112*b*** is formed. In this embodiment, due to the isolation structures **10*a*** and **10*b*** being composed of oxide, the modified parts **120** are preferably composed of oxide, for being removed together with the isolation structures **10*a*** and **10*b*** in later processes. The treatment process Q**2** is preferably an oxidation process, which may be an oxygen gas-containing process or an in situ steam generation (ISSG) process.

After the modified parts **120** are formed, the patterned mask **20*a*** is removed, as shown in FIG. **5**. Thereafter, a removing process Q**3** is performed to remove the modified parts **120** and a part of the isolation structures **10*a*** and **10*b*1** simultaneously, to form a top part **112*a*1** of each of the first fin-shaped structures **112*a*** and a second top part **112*b*2** of each of the second fin-shaped structures **112*b***. In this embodiment, the modified parts **120** and the part of the isolation structures **10*a*** and **10*b*1** are removed simultaneously without removing the first fin-shaped structures **112*a*** and the second fin-shaped structures **112*b*** by the high removing selectivity of the removing process Q**3** to the first fin-shaped structures **112*a*** and the second fin-shaped structures **112*b*,** and the modified part **120** and the isolation structures **10*a*** and **10*b*1**.

Each of the second fin-shaped structures **112*b*** having a ladder-shaped cross-sectional profile part C**1** can be formed while reserving the original first fin-shaped structures **112*a***. The ladder-shaped cross-sectional profile part C**1** has a bending angle θ**1**, which is preferably larger than or equal to 90°. It is emphasized that a specific following structure is formed by applying the method of forming a fin-shaped structure of the present invention. The width w**1** of the top part of each of the first fin-shaped structures **112*a*** comprising a first fin and a second fin is larger than a width w**3** of a top part of each of the second fin-shaped structures **112*b*** comprising a third fin and a fourth fin. The first distance p**1** between adjacent top corners of the first fin and the second fin of the first fin-shaped structures **112*a*** is less than a second distance p**3** between adjacent top corners of the third fin and the fourth fin of the second fin-shaped structures **112*b*** while a third distance p**5** between adjacent lower parts of the first fin and the second fin is the same as a fourth distance p**6** between adjacent lower parts of the third fin and the fourth fin. The ladder-shaped cross-sectional profile part C**1** of each of the second fin-shaped structures **112*b*** is higher than a top surface T**2** of the isolation structure **10*b*1**. A top surface T**3** of the isolation structure **10*a*** in the first area A is higher than the top surface T**2** of the isolation structure **10*b*1** in the second area B. A height h**3** of each of the first fin-shaped structures **112*a*** protruding from the isolation structure **10*a*** is lower than a height h**4** of each of the second fin-shaped structures **112*b*** protruding from the isolation structure **10*b*1**. The height h**1** of each of the first fin-shaped structures **112*a*** protruding from the substrate **110** is higher than a height h**5** of each of the second fin-shaped structures **112*b*** protruding from the substrate **110**.

Thereafter, processes such as forming gates or transistors may be performed. For instance, a gate may be formed across the first fin-shaped structures **112*a*** of the first area A and the second fin-shaped structures **112*b*** of the second area B respectively; a source/drain may be formed in the first fin-shaped structures **112*a*** and the second fin-shaped structures **112*b*** beside the gates respectively; and an interdielectric layer may be formed to cover the gates, the first fin-shaped structures **112*a*** and the second fin-shaped structures **112*b***.

The first fin-shaped structures **112*a*** and the second fin-shaped structures **112*b*** having ladder-shaped cross-sectional profile parts C**1** are formed and then the gates are formed on the first fin-shaped structures **112*a*** and the second fin-shaped structures **112*b*,** thereby the whole second fin-shaped structures **112*b*** of the second area B have a ladder-shaped cross-sectional profile parts C**1** in the first embodiment.

A second embodiment is presented in the following. Common first fin-shaped structures and second fin-shaped structures are formed firstly and gates are formed across the first fin-shaped structures and the second fin-shaped structures, and then parts of the first fin-shaped structures and the second fin-shaped structures are exposed to form the second fin-shaped structures having ladder-shaped cross-sectional profile parts by applying the present invention. In this way, only the parts of the second fin-shaped structure right below the gates have the ladder-shaped cross-sectional profile parts.

FIGS. **6**-**10** schematically depict a cross-sectional view of a method of forming a fin-shaped structure according to a second embodiment of the present invention. As shown in FIG. **6**, a substrate **110** is provided. The substrate **110** can be divided into a first area A and a second area B. In this embodiment, two first fin-shaped structures **212*a*** are formed in the first area A and two second fin-shaped structures **212*b*** are formed in the second area B, but the number of the first fin-shaped structures **212*a*** or the second fin-shaped structures **212*b*** is not restricted thereto. As in the first embodiment, the first fin-shaped structures **212*a*** and the second fin-shaped structures **212*b*** are common structures. Therefore, symmetric structures are formed in the first area A and the second area B. When a selective treatment process performed on one single area or on a plurality of areas, symmetric structures in these areas can receive the same influence and thus uniform structures can be formed. The methods of forming the first fin-shaped structures **212*a*** and the second fin-shaped structures **212*b*** which are common to those of the first embodiment are not described herein.

Isolation structures **30*a*** and **30*b*** are filled beside the first fin-shaped structures **212*a*** in the first area A and beside the second fin-shaped structures **212*b*** in the second area B respectively. The isolation structures **30*a*** and **30*b*** may be shallow trench isolation (STI) structures, and may include oxide. In this embodiment, the isolation structures **10*a*** and **10*b*** are filled beside the first fin-shaped structures **212*a*** in the first area A and beside the second fin-shaped structures **212*b*** in the second area B simultaneously, therefore the isolation structures **30*a*** and **30*b*** will have the same height. Symmetric structures are formed in the first area A and the second area B. When a selective treatment process is performed on one single area or on a plurality of areas, symmetric structures in these areas can receive the same influence and thus uniform structures can be formed. In another embodiment, the isolation structures **30*a*** and **30*b*** may have different heights and maybe formed by different processes, depending upon practical requirements. Moreover, after the first fin-shaped structures **212*a*** and the second fin-shaped structures **212*b*** are formed, a doping process may be selectively performed to form wells in the first area A and the second area B respectively or to change threshold voltages in the two areas.

A first gate **220*a*** is formed across the first fin-shaped structures **212*a*** of the first area A and a second gate **220*b*** is formed across the second fin-shaped structures **212*b*** of the second area B. More precisely, the first gate **220*a*** may include a first dielectric layer **222*a*** and a first sacrificial gate **224*a*** from bottom to top to cover the first fin-shaped structures **212***a,* and the second gate **220***b* may include a second dielectric layer **222***b* and a second sacrificial gate **224***b* from bottom to top to cover the second fin-shaped structures **220***b*. Spacers **230***a* and **230***b* may be formed on the isolation structures **30***a* and **30***b* beside the first gate **220***a* and the second gate **220***b* respectively. Interdielectric layers **240***a* and **240***b* may be formed to blanket the substrate **110** beside the first gate **220***a* and the second gate **220***b*. In this embodiment, the first dielectric layer **222***a* and the second dielectric layer **222***b* may be oxide layers, the first sacrificial gate **224***a* and the second sacrificial gate **224***b* may be polysilicon gates, the spacers **230***a* and **230***b* maybe nitride spacers, and the interdielectric layers **240***a* and **240***b* may be oxide layers, but this is not limited thereto. The methods of forming the first gate **220***a* and the second gate **220***b,* the spacers **230***a* and **230***b* and the interdielectric layers **240***a* and **240***b* are known in the art, and are not described herein.

An etching process may be performed to remove the first sacrificial gate **224***a* and the second sacrificial gate **224***b* and expose the first dielectric layer **222***a* and the second dielectric layer **222***b*, to thereby form recesses R**1** and R**2** in the first area A and the second area B respectively, as shown in FIG. **7**.

As shown in FIG. **8**, a mask K**2** is formed to cover only the first area A but expose the second area B. In this embodiment, the mask K**2** fills the recess R**1** of the first area A. FIGS. **7**-**8** illustrate a removing process Q**4** being performed to remove an external surface S**1** of a top part of each of the second fin-shaped structures **212***b* (as shown in FIG. **7**), to form second fin-shaped structures **212***b*' having ladder-shaped cross-sectional profile parts C**2**, wherein the ladder-shaped cross-sectional profile parts C**2** have a bending angle θ**2**, and the bending angle θ**2** is preferably larger than or equal to 90°. In this embodiment, the second dielectric layer **222***b* and the top part **30***bt* of the isolation structure **30***b* below the second dielectric layers **222***b* are removed as the removing process Q**4** is performed to remove the external surfaces S**1** of the second fin-shaped structures **212***b*. An isolation structure **30***b***1** is formed, and a top surface T**4** of the isolation structure **30***b***1** at the bottom of the recess R**2** is lower than a top surface T**5** of isolation structure **30***b***1** beside the recess R**2**, and even lower than a top surface T**6** of the isolation structure **30***a* in the first area A, depending upon the etchants of the removing process Q**4** and a desired formed structure. In another embodiment, modified parts may be formed from the top parts of the second fin-shaped structures **212***b* as described in the first embodiment, and then the modified parts are removed.

It is emphasized that, since the second dielectric layer **222***b* and the second fin-shaped structures **212***b* below the second dielectric layer **222***b* are removed by the removing process Q**4**, the removing process Q**4** has non-removing selectivity to the second dielectric layer **222***b* and the second fin-shaped structures **212***b*. This means the removing rate of the removing process Q**4** to the second dielectric layer **222***b* is equal to that of the second fin-shaped structures **212***b*. In one case, the removing process Q**4** may be a fluorine containing process. Since the second dielectric layer **222***b* is an oxide layer and the isolation structure **30***b* is composed of oxide, a part of the isolation structure **30***b* in the recess R**2** is also removed when the removing process Q**4** for removing the second dielectric layer **222***b* is performed.

After the second fin-shaped structures **212***b*' having ladder-shaped cross-sectional profile parts C**2** are formed, the mask K**2** and the first dielectric layer **222***a* in the first area A are removed, as shown in FIG. **9**. In this embodiment, the mask K**2** may be removed by an θ**2** stripping process, and the first dielectric layer **222***a* may be removed by an ammonia and nitrogen trifluoride containing etching process, but this is not limited thereto. As shown in FIG. **10**, dielectric layers **250***a* and **250***b* cover the first fin-shaped structures **212***a* and the second fin-shaped structures **212***b*' respectively. The dielectric layers **250***a* and **250***b* may be formed by the same process and have the same thickness, or may be formed by different processes or materials to have different thicknesses. For instance, the first area A is a high voltage threshold (HVT) area while the second area B is a low voltage threshold (LVT) area, so the thickness of the dielectric layer **250***a* of the first area A is larger than the thickness of the dielectric layer **250***b* of the second area B; or, the materials of the dielectric layers **250***a* and **250***b* may be different, enabling the dielectric layer **250***a* to have the capability of preventing high voltages while the dielectric layer **250***b* has lower Equivalent Oxide Thickness (EOT).

In this embodiment, the first dielectric layer **222***a* is removed and then the dielectric layers **250***a* and **250***b* are reformed. In other embodiments, the first dielectric layer **222***a* may not be removed while the dielectric layers **250***a* and **250***b* are formed directly on the first dielectric layer **222***a;* or, only the dielectric layer **250***b* in the second area B is formed. As shown in FIGS. **8**-**9**, the mask K**2** is formed, and the first dielectric layer **222***a* is then removed completely in this embodiment. In another embodiment, the first dielectric layer **222***a* and the second dielectric layer **222***b* may be removed before the mask K**2** is formed.

To summarize, the present invention provides a fin-shaped structure and method thereof, which covers a mask in a first area, and then removes an external surface of a top part of a second fin-shaped structure of a second area, so that a part, or all, of the second fin-shaped structures in the second area having ladder-shaped cross-sectional profiles can be formed. Hence, fin-shaped structures having different heights and critical dimensions can be formed in different areas, and thus transistors for each area can achieve their electrical requirements.

The methods of removing the external surface of the top part of the second fin-shaped structure in the second area after covering the mask in the first area may include: performing a removing process to directly remove the external surface of the top part of the second fin-shaped structure, wherein the removing process has non-removing selectivity to the second fin-shaped structure and materials except for those above the second fin-shaped structure such as dielectric layers or isolation structures, to remove them. In addition, a treatment process may be performed to modify the external surface of the top part of the second fin-shaped structure in the second area, and then the removing process is performed to remove the modified part, wherein the removing process has high removing selectivity to the modified part and the original second fin-shaped structure, so that the modified part can be removed without removing the second fin-shaped structure.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. A method of forming a fin-shaped structure, comprising:

providing a substrate having a first fin-shaped structure located in a first area and a second fin-shaped structure located in a second area;

forming a first gate across the first fin-shaped structure and a second gate across the second fin-shaped structure, wherein the first gate sequentially comprises a first dielectric layer and a first sacrificial gate covering the first fin-shaped structure, and the second gate sequentially comprises a second dielectric layer and a second sacrificial gate covering the second fin-shaped structure;

removing the first sacrificial gate and the second sacrificial gate, thereby exposing the first dielectric layer and the second dielectric layer;

covering a mask in the first area but exposing the second area;

performing a removing process to remove an external surface of a top part of the second fin-shaped structure; and

removing the mask.

2. The method of forming a fin-shaped structure according to claim **1**, further comprising:

forming a dielectric layer covering the first fin-shaped structure and the second fin-shaped structure after the mask is removed.

3. The method of forming a fin-shaped structure according to claim **1**, wherein the external surface of the top part of the second fin-shaped structure and the whole second dielectric layer are removed by the removing process.

4. The method of forming a fin-shaped structure according to claim **1**, further comprising:

removing the first dielectric layer completely after the mask is removed.

5. The method of forming a fin-shaped structure according to claim **1**, further comprising:

removing the first dielectric layer and the second dielectric layer completely before covering the mask.

6. The method of forming a fin-shaped structure according to claim **1**, further comprising:

forming an isolation structure beside the first fin-shaped structure of the first area and beside the second fin-shaped structure of the second area respectively after the substrate is provided, wherein a top part of the isolation structure of the second area is also removed while the removing process is performed.

7. The method of forming a fin-shaped structure according to claim **1**, wherein the removing process has no removing selectivity to the isolation structure and the second fin-shaped structure.

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